Acta Tropica 153 (2016) 36–45

Contents lists available at ScienceDirect

Acta Tropica

journal homepage: www.elsevier.com/locate/actatropica

Parasitism of the isopod *Artystone trysibia* in the fish *Chaetostoma dermorhynchum* from the Tena River (Amazonian region, Ecuador)

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ARTICLE INFO

Article history:
Received 31 May 2015
Received in revised form 5 October 2015
Accepted 6 October 2015

Keywords:
Artystone trysibia
Isopoda
Parasite
Freshwater
Ecuador

ABSTRACT

The isopod *Artystone trysibia* Schioedte, 1866 is described by using a collection of specimens that were found parasitizing loricariid fish *Chaetostoma dermorhynchum* Boulenger, 1887 in the Tena River (Napo province, Ecuador, Amazonian region). Additionally to freshly collected specimens, complementary data of the parasite was obtained from preserved fishes at Ecuadorian museums. This is the first record of *A. trysibia* in Ecuador, and the most upstream location for the species. The new host fish, *Chaetostoma dermorhynchum,* is used locally as food.

1. Introduction

The only record of an isopod fish parasite in Ecuadorian rivers is that of Leigh-Sharpe (1937) on the description of *Asotana splendida* (Leigh-Sharpe, 1937), as a single female taken from an unidentified fish (commonly named as "Boca Chica") in the Napo River.

The unique characteristics of this species (see Brusca, 1981) encouraged a sampling campaign to collect this and other parasitic isopods in the rivers of the Napo basin. Despite such efforts, no additional specimens of *A. splendida* have been collected so far. However, the sampling process provided observations on the loricariid *Chaetostoma dermorhynchum* Boulenger, 1887, a fish which is locally used as food, and that is infected by *Artystone trysibia* Schioedte, 1866; other Cymothoidae species that was unknown in Ecuador.

A. trysibia was originally described by Schioedte (1866) on the basis of a single female specimen collected in the Plata River, Argentina. A second specimen was described and illustrated by Schioedte and Meinert (1884). The species was characterized as having claws on the first six pairs of pereopods but not in the seventh, and an unfused pleon with free segments. These two character states are used by subsequent authors to distinguish *A. trysibia* from other Cymothoidae, which lack detailed descriptions for the species as it is commonly for several members in this family (Brusca, 1981). An unusual characteristic of the species in the genus *Artystone* is that they live encapsulated in the body cavity of the host. This is a property also shared by the South American Cymothoidae *Riggia* Szidat, 1948. The capsule than envelopes the isopod is formed by the body of the fish as a retaining wall, and the isopod maintains an opening to the outside with the movement of its pleopods (Huizinga, 1972). This adaptation contrasts to freshwater species in the family that usually attach externally to hosts' skin, fins, gill chambers or mouth (Thatcher, 2006).

A. trysibia has reported in fishes of rivers and lakes in Paraguay (Rowntree, 1903; Szidat, 1955), Brazil (Van Name, 1936; Leigh-Sharpe, 1937; Lemos de Castro and Machado Filho, 1946; Szidat, 1955; Pugues et al., 1998), and Venezuela (Szidat, 1955; Bowman and Díaz-Ungría, 1957; Martínez and Royero, 1989). The parasite has also been observed in ornamental fishes at ponds and aquaria (Weibezahn and Ramírez, 1957, Huizinga, 1972). As noted by Thatcher and Carvalho (1988), the available descriptions for *A. trysibia* do not include sufficient details on its morphology, making necessary further description for the species.

This paper provides a description of *A. trysibia* based on fresh specimens collected in the Tena River (Amazonian Ecuador). The description includes aspects of the parasitism in *Chaetostoma dermorhynchum*, a previously unknown fish host, locally named as "carachama". This is the first record of *A. trysibia* in Ecuador, and also the most upstream known location for the species in South America.

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http://dx.doi.org/10.1016/j.actatropica.2015.10.006
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2. Material and methods

Three sampling stations were selected along the upper course of the Tena River (Fig 1). This is a pristine area, unaffected by urban or industrial pollution. Sampling stations served as the starting points for moving upstream and casting fishing nets in all likely areas (Table 1).

Fishes were caught with an *atarraya* net, a traditional hand cast net (3 m diameter, 15 mm mesh size) used in Amazonian rivers. Sampling periods started at 19 h and lasted for two hours. Due to changing fluvial morphology and weather conditions, no attempt to standardize the fishing protocol was made. To determine the presence of the isopod in small-sized *C. dermorhynchum*, a total of 34 fish were caught by hand at Station 3 (Fig. 1).

After each sampling period, fishes were transferred alive to the laboratory for their examination. The water in which the fishes were transported was also screened for the presence of parasites.

Table 1
Collection data associated to sampling stations along the Tena River, Ecuador.

Station	Sampling date	high m	Coordinates	
1-Shiri	3 April 2015	760	0°55′13″S	77°52′42″W
2-Atacapi	5 April 2015	640	0°56′55″S	77°51′37″W
3-Ikiam	28 February 2015	615	0°57′27″S	77°51′36″W

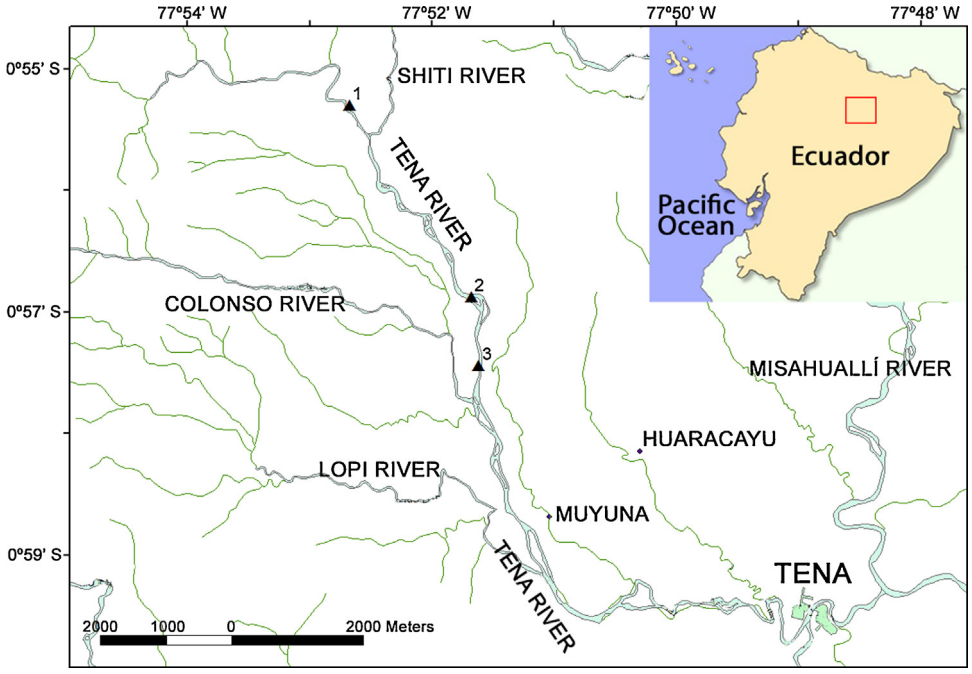


Fig. 1. Map of sampling stations along the Tena River, Ecuador.

Table 2
Characteristics of *Artystone trysibia* specimens and its fish host collected in the Tena River. L: length; W: width, BI: body index. Side, l: left; r: right. Capsule opening position A: lateral above the pectoral fin, B: ventral, C: lateral between pectoral and pelvic fin; D: lateral above the pelvic fins, and E: lateral below the dorsal fin (see Fig. 8).

N°	Station	Artystone trysibia					Host *C. dermorhynchum*		
		L	W	BI	Sex	Marsupium	L	opening	
		mm	mm				cm	side	position
#1	3-Ikiam	21	12	1.75	♀	Empty	11	l	D
#2	3-Ikiam	23	13	1.77	♀	366 juveniles(Stage V)	12.5	r	B
#3	3-Ikiam	26	13	2.00	♀	828 embryos(stage IV)	12.5	r	B
#4	3-Ikiam	17	11	1.55	♀	Empty	9	r	D
#5	3-Ikiam	15	10	1.50	♂		10	l	D
#6	3-Ikiam	19	13	1.46	♀	Broken, (stage II)	10	l	D
#7	3-Ikiam	19	13	1.46	♀	Broken (stage II)	9	l	D
#8	3-Ikiam	17	14	1.21	♀	Empty	9	l	C
#9	3-Ikiam	20.5	11	1.86	♀	311 juveniles(stage IV)	10	l	D
#10	1-Shiri	15	12	1.25	♀	Empty	9	l	D
#11	1-Shiri	19	14.5	1.31	♀	388 eggs (Stage II)	10.5	r	E
#12	1-Shiri	17.5	12	1.46	♂		11	r	D
#13	1-Shiri	22	14	1.57	♀	393 eggs (Stage II)	11.7	r	D
#14	1-Shiri	18	12.2	1.48	♀	Empty	10.5	r	D
#15	1-Shiri	20	14	1.43	♀	Empty	10.5	r	A
#16	1-Shiri	14.3	9.8	1.46	♂		9.5	r	D
#17	1-Shiri	16.7	10.5	1.59	♀	180 eggs (Stage II)	9.5	r	D
#18	1-Shiri	15	10.5	1.43	♀	94 eggs (Stage II)	8	r	D
#19	1-Shiri	16	11	1.45	♂		8.5	r	D
#20	1-Shiri	14.4	12	1.20	♀	Empty	8.5	l	D
#21	1-Shiri	16.3	10.2	1.60	♀	Empty	9.8	r	D
#22	2-Atacapi	29	19	1.52	♂		16	r	C

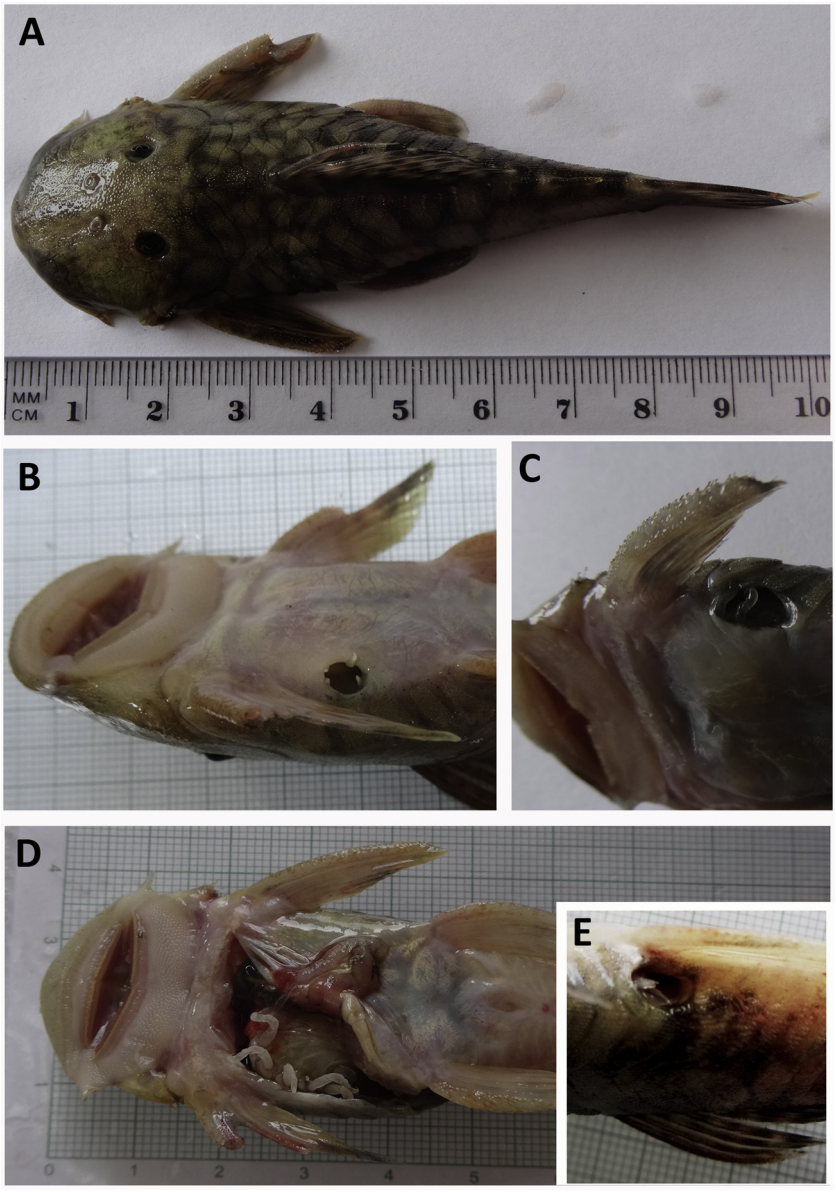


Fig. 2. Parasitized specimens of *Chaetostoma dermorhynchum* from Tena River, Ecuador. (**A**) Dorsal view of specimen #8. (**B**)Ventral view of specimen #2 showing the ventral pocket opening. (**C**) Lateral view of specimen #8 showing the lateral pocket opening, close to the left pectoral fin. (**D**) Ventral view of dissected specimen #11 showing the parasitic isopod *Artystone trysibia*. (**E**) Lateral view of specimen #11 showing the lateral pocket opening above the right pelvic fin.

Fish total length and position of pocket opening in parasitized specimens were recorded. Fishes were grouped in size classes (i.e. class 4 between 40–49 mm, class 5 between 50–59 mm, and so on). After the death of the fishes, the isopods were dissected out with the aid of scissors and forceps, and stored in 70% ethanol. Fish host and parasite were labeled with the same number to related each other.

Artystone trysibia is a hermaphrodite protandricous species (Brusca 1981; Thatcher 2006) and in some individuals sex determination is difficult because of the presence of intermediate

Table 3
Numbers of sensory hooks and bifid spines on *Artystone trysibia* pereopods

	Sensory hooks		Bifid spines					
Pereiopod	Propopus		Merus		Carpus		Propodus	
	♀	♂	♀	♂	♀	♂	♀	♂
PI	4	4						
PII	5	6					2	8
PIII	5	6						8
PIV	5	4					9	6
PV	3	4		2	3		17	12
PVI	3	4		2	4	4	22	21
PVII			10	11	21	22	35	44

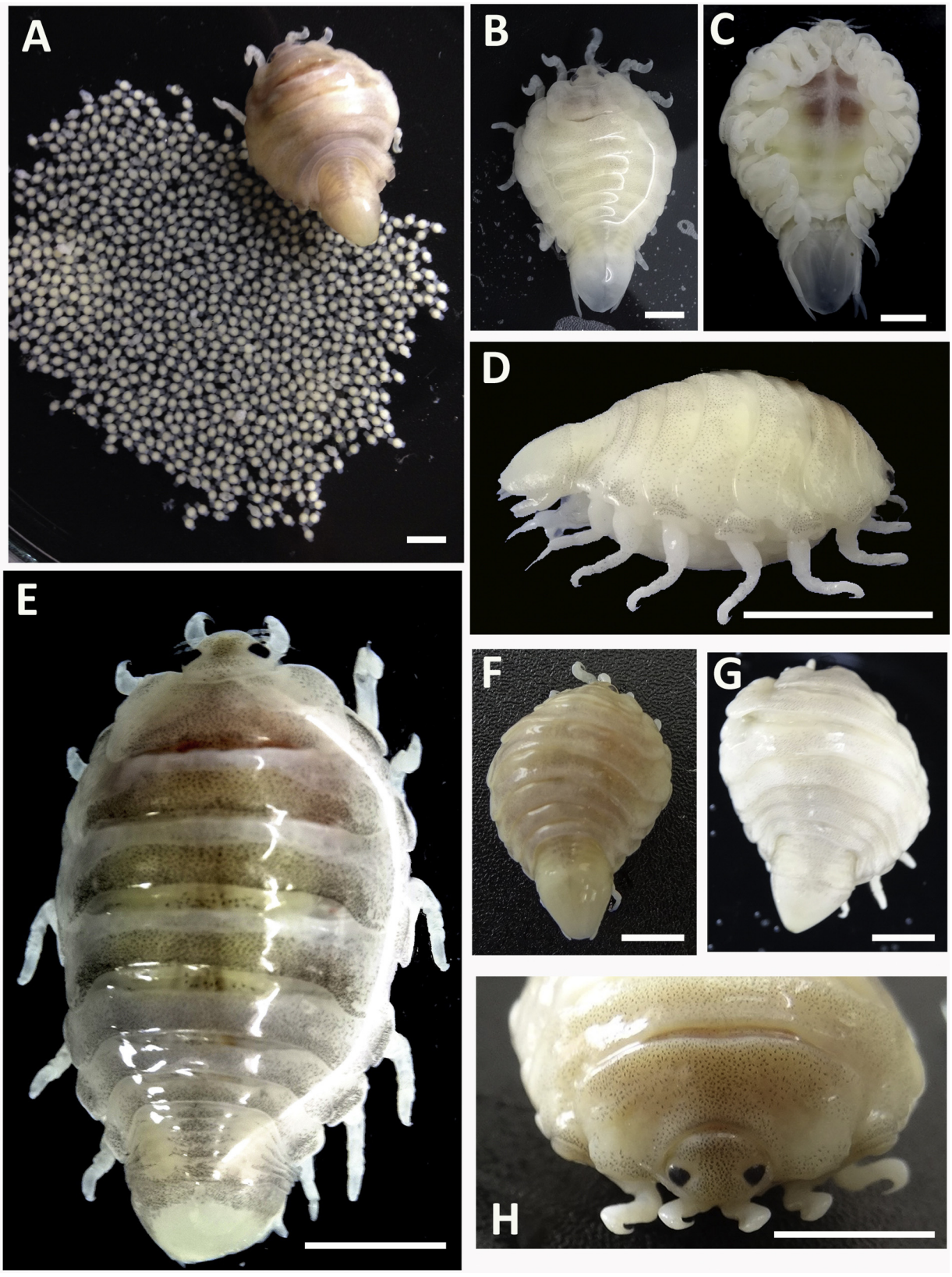


Fig. 3. The parasitic isopod *Artystone trysibia* from Tena River, Ecuador. (**A**) Specimen #3, a brooding female and its 828 embryos. (**B**) Dorsal view of male specimen #22. (**C**) Ventral view of male specimen #22. (**D**) Lateral view of specimen #18, a female carrying 98 eggs in its marsupium. (**E**) Dorsal view of specimen #9, a female carrying 311 young manca in its marsupium. (**F**) Dorsal view of female specimen #7, a brown twisted specimen. (**G**) Dorsal view of female specimen #6, a white twisted specimen. (**H**) Frontal view of female specimen #2. Scale bar = 5 mm.

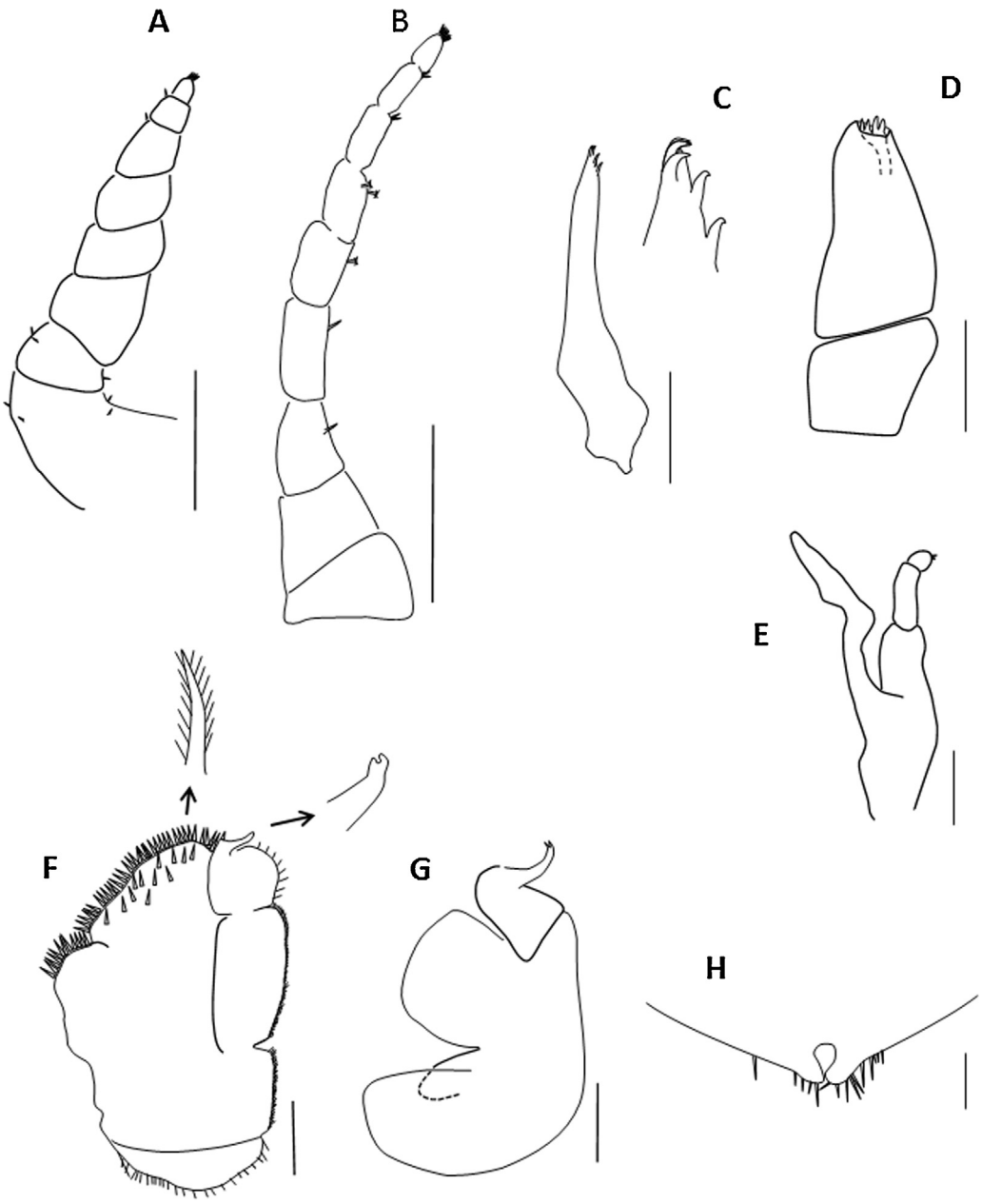


Fig. 4. *Artystone trysibia,* female (A–F), male (G–H). A, antenna 1. B, antenna 2. C, maxilla 1. D, maxilla 2. E, mandible. F, maxilliped. G, maxilliped. H, pereon sternite VII. Scale bar = 0.5 mm.

sexual characters. Specimens with penes lacking oostegites were considered as males. All isopod specimens were measured on length and width, and the proportion of these two measures was considered as body index (length divided by width). Any eggs, embryos or juveniles in intact marsupia were removed, counted and assigned to a development state as described by Pugues et al. (1998). Selected specimens were dissected in order to get an accurate comparison of morphological features. Mouthparts and appendages were carefully dissected and illustrated.

Additional to the collected specimens at Tena River, three additional specimens of *A. trysibia* were obtained from preserved fishes at the Museo del Instituto de Ciencias Biológicas, Escuela Politécnica Nacional (MEPN) and Museo Ecuatoriano de Ciencias Naturales, (MECN) in Quito, Ecuador.

3. Results

3.1. Taxonomy

Order Isopoda Latreille, 1817
Suborder Cymothoida Wägele, 1989
Family Cymothoidae Leach, 1818
Genus *Artystone* Schioedte, 1866
A. trysibia Schioedte, 1866

A. trysibia Schioedte, 1866; p. 206, Pl. XI, Fig. 4a–i; Schioedte and Meinert 1884; p. 402, Pl. XVIII, Figs. 1–4; Richardson 1904; p. 23; Van Name, 1936, p. 445, Fig. 278; Leigh-Sharpe 1937; p. 394; Van Name, 1940; p. 132; Lemos de Castro and Machado Filho, 1946; p. 407–413, Fig. 1–22; Martínez and Royero 1989; p. 127–130, Fig. 1–4; Pugues et al., 1998, p. 47–53.

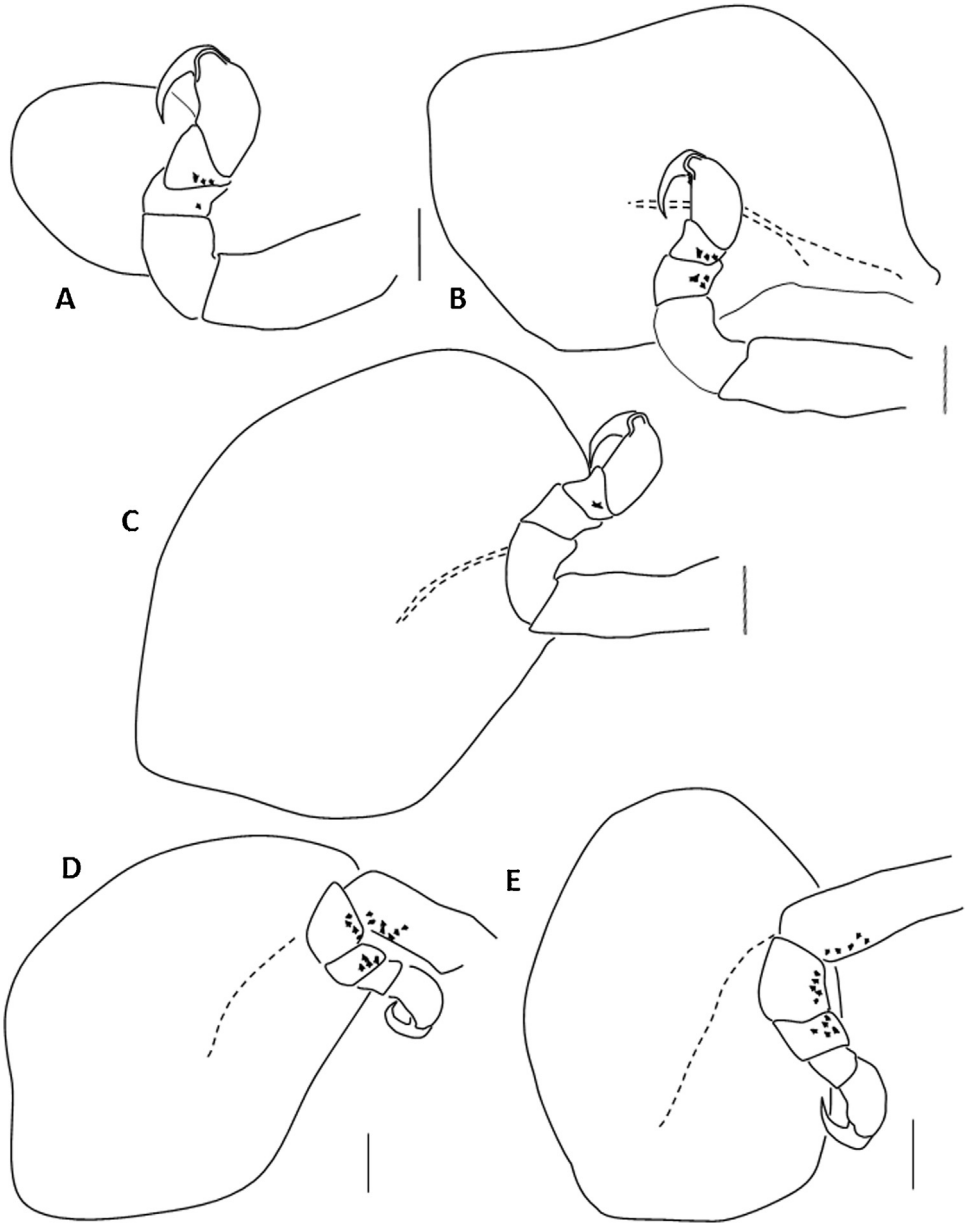


Fig. 5. *Artystone trysibia,* female left pereopods. A, pereopod I and oostegite. B, pereopod II and oostegite. C, pereopod III and oostegite. D, pereopod IV and oostegite. E, pereopod V and oostegite. Scale bar = 1 mm.

3.2. Material examined

Tena River, Muyuna, Tena, Ecuador. Station 3-Ikiam, 23 February 2015, 8 ♀, 1 ♂; Station 1-Shiri, 3 March 2015, 9 ♀ 3 ♂; Station 2-Atacapi, 5 March 2015, 1 ♂. Additional specimen information in Table 2; all specimens were found in *C. dermorhynchum* (Figs. 2 and 3).

MEPN-Tupanisco River, close to Loreto, Ecuador (0°30′01″S, 77°14′05″W), April 1952, 1 ♀ with oostegites, 22.8 × 14.2 mm, extracted from a preserved *C. dermorhynchum* 137.2 mm, with lateral opening over the right pelvic fin (catalogue number MEPN 10579). Cotapino River, Ecuador (0°46′45″S, 77° 27′55″W). 5 August 1966, 1 ♀ with oostegites, 18.8 × 14.2 mm, extracted from a preserved *C. dermorhynchum* 108.9 mm, with lateral opening over the left pelvic fin.

MECN-Small unnamed river tributary of the San Miguel River, 6 October 2010, 1 ♀ with oostegites, 23.2 × 16.2 mm, extracted from a preserved *Chaetostoma* sp. 125 mm, with lateral opening over the left pelvic fin (catalogue number MECN 1845).

3.3. Description

Female (Fig. 3A, D–H). Length 14.4–26 mm (mean = 19.1) width 10.2–14.5 mm (mean = 12.7); body index 1.2–2.0. Colour white or light brown. Chromatophores over dorsal surface of the body, also present on the outer face of pereopods, especially IV–VI.

Cephalon: Eyes black and well developed. Antenna 1 short, with eight articles, and reaching the posterior margin of the eye. Antenna 2 with nine articles, and reaching the anterior margin of pereonite I (Fig. 4A,B). Maxilla 1 reduced to a slender stylet, with five spines, two subterminal and three terminal (Fig. 4C). Maxilla 2 with four distal spines (Fig. 4D). Mandible of the "tearing" type (Thatcher, 1997), bearing short spines, palp with three articles, in a terminal position and bearing 3 setae (Fig 4E). Expanded maxilliped, with

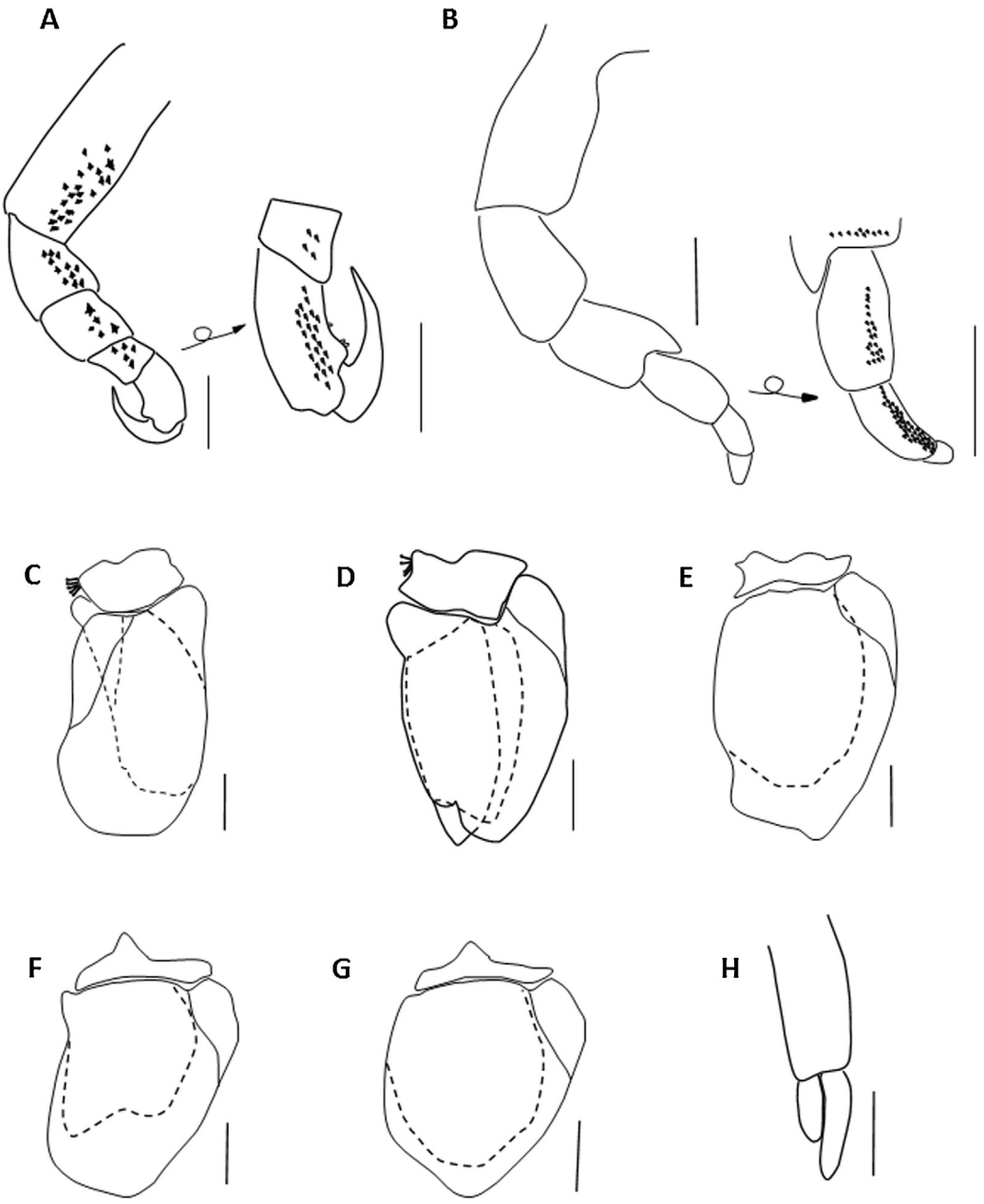


Fig. 6. *Artystone trysibia,* female. A, pereopod VI, in detail inner face with bifid spines. B, pereopod VII, in detail inner face with bifid spines. C, pleopod 1. D, pleopod 2. E, pleopod 3. F, pleopod 4. G, pleopod 5. H, Uropod. Scale bar = 1 mm.

numerous lateral plumose setae; palp of three articles, distal bifid (Fig. 4F).

Pereon: outline circular to oval (Fig. 3E), convex dorsally (Fig. 3D). Some specimens twisted (Fig. 3F,G). The body is widest at level of pereonite III. Pereonite I is the longest and VII the shortest. Epimera of pereonite VII produced posteriorly. Coxal plates II to VII dorsally visible in larger specimens (Fig. 3A,E). Pereopods I–VI subequal (Figs. 5, 6A ,), bearing claw-like dactyls; chromatophores on outer face of the articles as illustrated. Oostegites on pereopods I–V (Fig. 5). Pereopod VII longer than others, without claw nor chromatophores (Fig. 6B). Bifid spines present on inner face of pereopods as indicated in Table 3.

Pleon: all pleonites dorsally visible, pleonites 1–4 laterally overlapped by pereonite VII. Pleopods as illustrated (Fig. 6C–G), peduncule pleopod 1 and 2 with coupling hooks, pleopod 2 endopod bilaminate. Uropod smooth, without setae nor spines, endopod shorter (rarely equal) than exopod (Fig. 6H). Pleotelson broad, subtriangular, more or less truncate, oval in specimen #9 (Fig. 3E), probably altered by predation.

Fecundity: 94–828 eggs or juveniles (Table 2)

Male (Fig. 3B,C). Length 14.3–29 mm (mean = 18.3) width 9.8–19 mm (mean = 12.3); body index 1.43–1.52. Similar to female and usually smaller except for specimen #22, the largest one collected. Maxilliped smaller than female, without setation (Fig 4G). Penes on pereon sternite VII, with some spines (Figs. Fig.33C, Fig.44H); pleopod 2 similar to female, appendix masculina foliose.

3.4. Parasitism

A total of 317 specimens of *Chaetostoma dermorhynchum* were collected with a cast net and examined. Of these, 22 (6.94%) were parasitized, multiple isopods per host were never observed. Fig. 7 shows the size distribution of fishes. The total length ranged from 4 to 21 cm and for parasited fishes from 8.0 to 16.3 cm. No

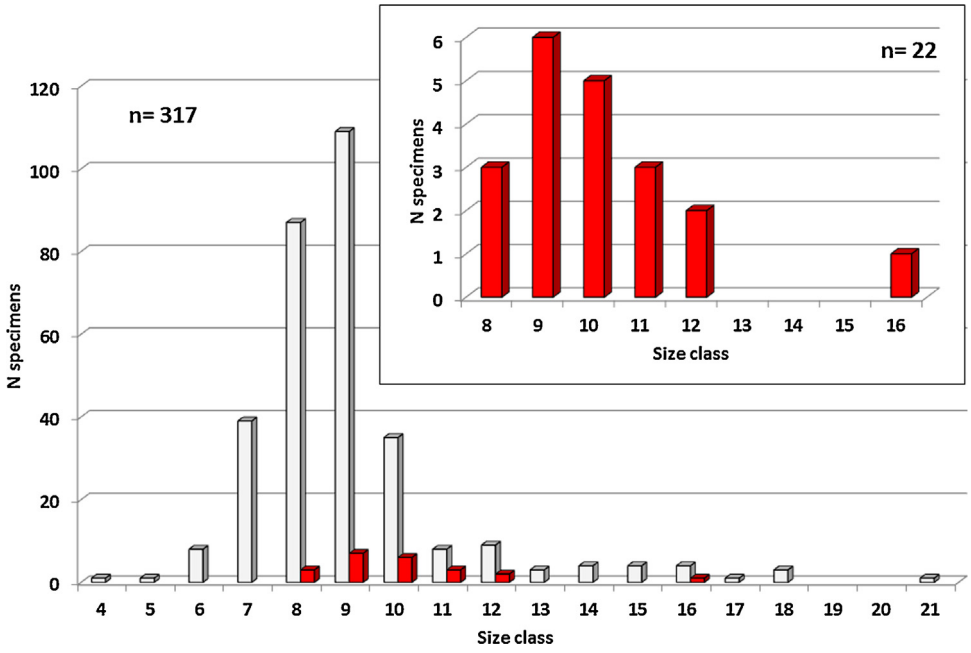


Fig. 7. Size class histograms of the *Chaetostoma dermorhynchum* collected at Tena River with net cast; bars in red belong to parasitized specimens. The figure in the box on the upper right corner corresponds to the histogram of infected hosts only.

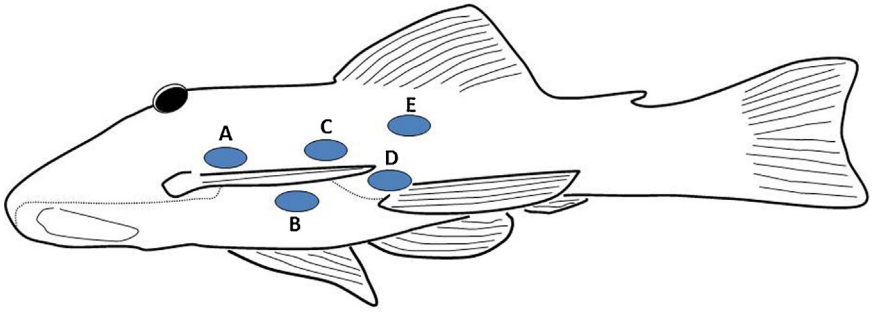
one of the 34 fish collected by hand was parasitized (2.2–9.4 cm; mean = 5.36 cm).

Fig. 8 shows the various positions found for the opening of the isopod capsule in the body of infested *C. dermorhynchum* specimens; these include: (A) lateral and above the pectoral fin, (B) ventral, (C) lateral and between pectoral and pelvic fins; (D) lateral and above the pelvic fin, and (E) lateral and below the dorsal fin. There is a higher frequency for apertures over the pelvic fin (72.7%); whereas there is a slight preference for the right side of the body (59.1% on right; 40.9% on left) (see Table 2). All isopods were aligned with head facing forward in relation to the host body and the pleotelson towards the fish tail, showing its distal tip and the end of pereopod VII by the capsule opening.

Table 2 lists the characteristics of the 22 specimens of *A. trysibia* collected in the Tena River. There is a strong relationship between lengths of both isopod and fish host (Fig. 9).

4. Discussion

The original description for *A. trysibia* is incomplete, and lacks information on host and parasite location. As a particular characteristic among Cymothoidae, Schioedte (1866) specified that the dactyl of the pereopod VII is not claw-like. Decades later, Szidat (1948) described the genus *Riggia*, morphologically similar to *Artystone*, and with the same type of pereopod VII. According to Szidat (1948) and Bastos and Thatcher (1997) *Riggia* can be distinguished



Aperture position	Righ	Left	Total
A	1		1
B	2		2
C	1	1	2
D	9	7	16
E		1	1

Fig. 8. Observed positions for the opening of the isopod capsule in *C. dermorhynchum* specimens. A: lateral and above the pectoral fin. B: ventral. C: lateral and between pectoral and pelvic fins. D: lateral and above the pelvic fin. E: lateral and below the dorsal fin.

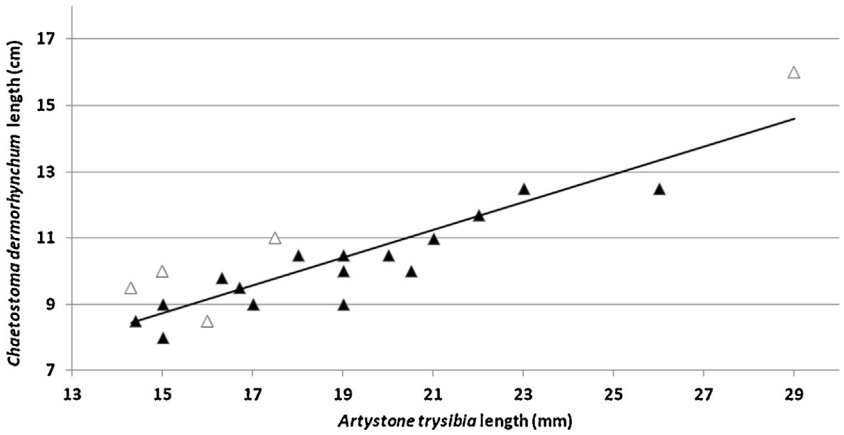


Fig. 9. Linear relationship between the size of *Artystone trysibia* and the size of its host *Chaetostoma dermorhynchum*. All the specimens belong to the Tena River. Black: female; white: male. ($y = 0.42x + 2.48$; $R^2 = 0{,}80$).

from *Artystone* in that the former has the pleon and pleotelson fused into a single unit in adult females, whereas the later has a pleon with visible segmentation. Both South American cymothoid genera also share the same type of parasitism by living encapsulated in the host fish (Szidat, 1948; Thatcher and Carvalho, 1988).

In spite of the resembling morphology of these two genera of parasites, there is no doubt that the specimens at the Tena River belong to the genus *Artystone*. These specimens have an unfused pleon and lack claws on the seventh pereopods. Three *Artystone* species have been described. *A. trysibia*, the type species in the genus, ranges from 22–25 mm in length; the other two species, *Artystone minima* Thatcher and Carvalho, 1988 and *Artystone bolivianensis* Thatcher and Schindler, 1999, are small and range from 2.5 to 6.9 mm in length (Thatcher and Carvalho, 1988; Thatcher and Schindler, 1999).

Lemos de Castro and Machado Filho (1946) described the male and provided illustrations for the mouthparts. Whereas female and male maxillipeds are similar to those described herein, the mandible is notably different and probably a misinterpretation of the specimen shape, as pointed out by Thatcher (1997). Lemos de Castro and Machado Filho (1946) also described a maxilla 1 with six spines, however the commonly observed number is a maximum of five in freshwater species (Thatcher, 1997), and is the same number found in specimens collected at the Tena River. Pereopod setation is a novel characteristic provided in the present study and was only known from the cogeneric *A. minima* (Thatcher and Carvalho, 1988).

A. trysibia infects several freshwater fish species (Table 4) and has also been recorded in estuarine fishes. Prevalence of parasitism in the host *C. dermorhynchum* at Tena River is relatively low (6.94%) compared to data provided by Martínez and Royero (1989) at Taguay River (Venezuela); these authors recorded infection rates of 12.14% in the fish *Petekia kraussii* and 29.30% in *Aequidens pulcher*. High prevalence of parasitism (82%) has been recorded for the cogeneric *A. bolivianensis* (Thatcher and Schindler, 1999).

In experimental aquaria the mancas released from the marsupium of the female swim actively searching a suitable fish host (Huizinga 1972; Alberto et al., 2009) and high rates of infection occurred. Location for a suitable host in the rushing waters of the Tena River will be harder and more random than aquaria conditions; thus, high fecundity of females is expected for this environment. According to Pugues et al. (1998), the number of eggs/juveniles recorded in the marsupium at lake Guaíba (Brazil) varies from 55 to 198 (mean = 115.6, $n = 10$ females) whereas in Tena River it varies from 94 to 828 (mean = 361.4, $n = 7$ females).

Table 4
List of localities and host records for *Artystone trysibia*.

Reference	Locality	Host fish
Schioedte (1866)	Plata River, Argentina	
Van Name (1936)	Roraima River, Brazil	
Leigh-Sharpe (1937)	Humboldt River, Brazil	*Geophagus brasiliensis*
Coventry (1944)		*Bagre panamensis*
Lemos de Castro and Machado Filho (1946)	Itajaí do Norte River, Brazil	*Geophagus brasiliensis*, *Crenicichla lacustris*
Szidat (1955)	Humboldt River, Brazil; Parana River, Paraguay; Plata River, Argentina	*Geophagus brasiliensis*
Bowman and Díaz Ungría (1957)	Amacuro Delta, Venezuela	Fam. Anostomidae
		Fam. Cinclidae
Weibezahn and Ramírez (1957)	Caracas, Venezuela (ornamental pond)	*Aequidens pulcher*
		Aequidens tetramerus
		Mollienesia sphenops
Huizinga (1972)	USA (aquaria)	*Corydoras aeneus*
		Symposodon discus
Martínez and Royero (1989)	Taguay River, Venezuela	*Petenia kraussii*
		Aequidens pulcher
Pugues et al. (1998)	Lago Guaíba, Porto Alegre, Brazil	*Geophagus brasiliensis*
		Gymnogeophagus gymnogenys
		Pimelodella laticeps
		Cyanocharax alburnus
		Jenynsia multidentata
		Pimelodus maculatus
		Platanichthys platana
This paper	Tena River, Ecuador	*Chaetostoma dermorhynchum*

Specimen #3 (Fig. 3A) has the highest fecundity recorded for the species with 828 juveniles.

A. trysibia could eventually be a harmful parasitic species for aquaculture, because of its easy propagation in culture tanks and ornamental aquaria. In this sense, Weibezahn and Ramírez (1957) reported the isopod as the main cause of fish mortality in an ornamental pond. Mechanical damage to the host occurs during penetration of the fish body wall (Huizinga, 1972). In naturally infected discus fish, Huizinga (1972) noted a reduced histopathology, which was limited to organ compression and displacement. In the present study, the lesions produced by *A. trysibia* in *C. dermorhynchum* showed no evidence of inflammatory reaction or of secondary invasion by bacteria. The isopod occupied a notable volume in the body cavity of the host fish (Fig. 2D), and prejudicial effects in the proper development of internal organs, such as gonads, are probable. Parasitic castration has been observed in freshwater fishes caused by *Riggia paranensis*, a related isopod that also encapsulates in South American freshwater fishes (Azevedo et al., 2006).

This study describes the first record for *A. trysibia* in Ecuador (Tena, Tupanisco, Cotapino and San Miguel Rivers) and expands its distributional range westward (Table 4). Sampling localities include Andean tributaries of the Napo River, which is part of the main watershed of the Amazon. It is possible that the species is also present in other river systems that drain from the eastern slopes of the tropical Andes into the Amazon. The presence of the parasite does not appear to be the result of a recent infestation. The oldest specimen recorded in this study, as host to *A. trysibia*, belongs to MEPN and was collected in 1952. Kichwa people, natives from the study area, who for generations have known the fauna and rivers of the region, refer to the parasite by the common name of “ghili”.

Sponsorship

Proyecto Prometeo, Secretaría Nacional de Educación Superior, Ciencia, Tecnología e Innovación (SENESCYT, Gobierno de la República del Ecuador).

Acknowledgements

The author received a research grant from the Proyecto Prometeo, Secretaría Nacional de Educación Superior, Ciencia, Tecnología e Innovación (SENESCYT, Gobierno de la República del Ecuador) to study parasitic freshwater isopods in Tena. The Universidad Regional Amazónica Ikiam at Tena hosted the author for the duration of his research. The author thanks the staff and students at Ikiam for their support and hospitality. Dr. Raimundo Barriga from Univerisidad Politécnica Nacional and a Prometeo colleague, Dr. Francisco Provenzano, kindly provided specimens from the MEPN and identified the host *Chaetostoma dermorhynchum*; Jonathan Valdiviezo from MECN also provided other specimen. Alvaro Barragán, from Pontificia Universidad Católica del Ecuador, assisted with laboratory supplies at the start of the research. The author also thanks Dr Pablo Jarrin and Dr Jose Luis Sánchez for his valuable suggestions to improve this manuscript. Bayron Grefa assisted in field research as an expert fisherman

References

Alberto, R.M.F., Maciel, P.C., Araujo, P.B., 2009. Infestation by the freshwater cymothoid *Artystone trysibia* Schioedte (Crustacea, Isopoda): parasite and host behavior. J. Nat. Hist. 43, 47–56.

Azevedo, J.S., Gomes da Silva, L., Bizerril, C.R.S., Dansa-Petretski, M., Lima, N.R.W., 2006. Infestation pattern and parasitic castration of the crustacean *Riggia paranensis* (Crustacea, Cymothoidea) on the fresh water fish *Cyphocharax gilbert* (Teleostei Curimatidae). Neotrop. Ichthyol. 4, 363–369.

Bastos, P.B., Thatcher, V.E., 1997. A redescription of *Riggia paranensis* Szidat, 1948 (Isopoda, Cymothoidae) based on thirty-two specimens from Curimatid fish of Rio de Janeiro, Brazil, with an emendation of the genus. Mem. Ins. Oswaldo. Cruz 92, 755–760.

Boulenger, G.A., 1887. An account of the fishes collected by Mr. C. Buckley in eastern Ecuador. Proc. Zool. Soc. Lond. (pt 2), 274–283.

Bowman, T.E., Díaz-Ungría, C., 1957. Isópodos quimotoideos parásitos de peces de las aguas venezolanas. Mem. Soc. Cien. Nat. La Salle 17, 112–124.

Brusca, R.C., 1981. A monograph on the Isopoda Cymothoidae (Crustacea) of the Eastern Pacific. Zool. J. Linn. Soc.-Lond. 73, 117–199.

Coventry, G.A., 1944. The Crustacea. In: Vanderbilt, G. (Ed.), Results of the Fifth George Vanderbilt Expedition 1941 Bahamas, Caribbean Sea, Panamá, Galápagos Archipelago and Mexican Pacific Islands. Academy of Natural Sciences of Philadelphia, Philadelphia, pp. 531–544.

Huizinga, H.W., 1972. Pathobiology of *Artystone trysibia* Schioedte (IsopodaCymothoidae), an endoparasitic isopod of South American fresh water fishes. J. Wildlife Dis. 8, 225–232.

Leigh-Sharpe, W.H., 1937. *Badroulboudour splendida* n.g. et sp., a new parasitic isopod from Ecuador. Parasitol 29, 391–394.

Lemos de Castro, A., Machado Filho, J.P., 1946. *Artystone trysibia* Schioedte um crustáceo parasita de peixe de água doce do Brasil, com descriçao de alotipo macho (Isopoda, Cymothoidae). Rev. Brasil Biol. 6, 407–413.

Martínez, R., Royero, R., 1989. Nota acerca de la presencia del isópodo parásito *Artystone trysibia* Schioedte, 1866 (Isopoda; Cymothoidae) en peces del río Taguay Estado Aragua, Venezuela. Acta Biol. Venez. 12, 127–130.

Pugues, S.M., Alberto, R.M., Pereira, E.H.L., Bertoletti, J.J., 1866. Diferenciaçoes morfológicas no desenvolvimento embrionario de *Artystone trysibia* Schioedte, 1866 (Crustacea, Isopoda, Cymothoidae). Rev. Brasil Biol. 58, 47–53.

Richardson, H., 1904. Contributions to the natural history of the Isopoda. Proc. U. S. Nat. Mus. 27, 1–89.

Rowntree, W.S., 1903. On some points in the visceral anatomy of the Characinidae with an enquiry into the relations of the dusctus neumaticus in the Physonomy generally. Trans. Linn. Soc. Lond. 2 Ser. Zool. 9, 47–81.

Schioedte, J.C., 1866. Krebsdyrenes sugemund, Naturhist. Tiddskr. 3, 169–206.

Schioedte, J.C., Meinert, F., 1884. Symbolae ad monographiam cymothoarum crustaceorum isopodum familae. IV. Cymothoidae TRIB. II. Cymothoinae. TRIB. III. Livonecinae. Naturhist. Tidsskr. 14, 221–454.

Szidat, L., 1948. *Riggia paranensis* n.g.,n. sp., un isópodo parásito de la cavidad del cuerpo de *Curimata pistana* Günther, delrío Paraná. Rev. Inst. Inves. Cien. Natur. Cien. Zool. Buenos. Aires. 1, 45–56.

Szidat, L., 1955. Beitrage zur Kenntnis der Reliktfauna des La PlataStromsystems. Arch. Hidrobiol. 51, 209–260.

Thatcher VE. 1997. Mouthpart morphology of six freshwater species of Cymothoidae (Isopoda) from Amazonian fish compared to that of three marine forms, with the proposal of Artystonenae subfam. nov. Amazonia 3/4: 311-322.

Thatcher, V.E., 2006. Isopoda. In: Thatcher, V.E. (Ed.), Amazon Fish Parasites. , 2nd ed. Pensoft Publishers, Sofía, pp. 416–453.

Thatcher, V.E., Carvalho, M.L., 1988. *Artystone minima* n.sp. (Isopoda, Cymothoidae) a body cavity parasite of the pencil fish (*Nannostomus beckfordi* Guenther) from the Brazilian Amazon. Amazoniana 10, 255–265.

Thatcher, V.E., Schindler, I., 1999. *Artystone bolivianensis* n.sp. (Isopoda Cymothoidae) from a loricariid catfish of the Bolivian Amazon. Amazoniana 15, 183–191.

Van Name, W.G., 1936. The American land and fresh-water isopod Crustacea. Bull. Am. Mus. Nat Hist. 71, 22–508.

Van Name, W.G., 1940. A Supplement to the American Land and Fresh-Water Isopod Crustacea. Bull. Amer. Mus. Nat. Hist. 77, 109–142.

Weibezahn, H.F., Ramírez, V.M., 1866. Mortandad de peces de agua dulce causada por un crustáceo parásito, *Artystone trysibia* Schioedte, 1866 (Isopoda, Cymothoidae). Bol. Soc. Venez. Cien. Nat. 19, 153–156.